

APPARATUS AND METHOD TO CONTROL ACCESS TO LOGICAL VOLUMES

Field Of The Invention

The invention relates to an apparatus and method to control access to logical
5 volumes disposed in an information storage and retrieval system.

Background Of The Invention

In hierarchical computer storage systems, fast and intensively used storage are
paired with arrays of slower and less frequently accessed data devices. One example of
high-speed, expensive memory is a direct access storage device file buffer (DASD).
10 Slower storage devices include tape drives and disk drive arrays. Such tape drives and/or
disk drive arrays are often located in an information storage and retrieval system,
sometimes referred to as an automated media storage library.

Information storage and retrieval systems are known for providing cost effective
access to large quantities of stored information, such as backup computer files.
15 Generally, such information storage and retrieval systems include information storage
media, such as a plurality of tape cartridges, a plurality of optical cartridges, a plurality of
disk arrays, a plurality of electronic storage media, and the like. By electronic storage
media, Applicants mean a device such as a PROM, EPROM, EEPROM, Flash PROM,
and the like. A number of different companies manufacture automated media storage
20 libraries today, each model displaying various different features. One example is the
IBM TotalStorage® Enterprise Storage Server.

Storage area networks (SANs) are dedicated networks that connect one or more hosts or servers to storage devices and subsystems, such as an automated media library. SANs may utilize an appliance, such as a networked attached storage device ("NASD") to provide for management of the SAN.

- 5 What is needed is a method to control access to logical volumes disposed in an information storage and retrieval system, where multiple host computers owned by differing persons have access rights to one or more of those logical volumes.

Summary Of The Invention

Applicants' invention includes an apparatus and method to control access to
10 logical volumes disposed in an information storage and retrieval system. The method provides an information storage and retrieval system comprising a plurality of logical volumes, and a plurality of host computers, where each host computer is capable of communicating with the information storage and retrieval system.

Applicants' method forms (N) host computer groups, assigns one or more of the
15 plurality of host computers to the (i)th host computer group, where (i) is greater than or equal to 1 and less than or equal to (N), such that each host computer assigned to (i)th host computer group is not assigned to any other of the (N) host computer groups.

Applicants' method forms (N) logical volume groups, assigns one or more of the plurality of logical volumes to the (i)th logical volume group, such that each of said logical
20 volumes assigned to the (i)th logical volume group is not assigned to any other of the (N) logical volume groups.

second host computer 220, and a third host computer 230. Each of the first, second, and third host computers is interconnected with a storage area network ("SAN") 240. SAN 240 is interconnected with information storage and retrieval system 250.

FIG. 2B shows another embodiment of Applicants' data processing system. In the illustrated embodiment of FIG. 2B, system 201 includes a first host computer 210, a second host computer 220, a third host computer 230, and information storage and retrieval system 250. Each of the first, second, and third host computers is interconnected with information storage and retrieval system 250.

In certain embodiments, Applicants' data processing system includes one or more host computers that communicate with information storage and retrieval system 250 via a SAN as illustrated in FIG. 2A, in combination with one or more host computers that communicate with information storage and retrieval system 250 directly as illustrated in FIG. 2B.

The illustrated embodiments of FIGs. 2A and 2B include three host computers. In other embodiments, Applicants' data processing systems 200 / 201 include two host computers. In other embodiments, Applicants' data processing systems 200 / 201 include more than three host computers.

Host computer 210 comprises a computer system, such as a mainframe, personal computer, workstation, and combinations thereof, including an operating system 212 such as Windows, AIX, Unix, MVS, LINUX, etc. (Windows is a registered trademark of Microsoft Corporation; AIX is a registered trademark and MVS is a trademark of IBM Corporation; and UNIX is a registered trademark in the United States and other countries

licensed exclusively through The Open Group.) In certain embodiments, host computer 210 further includes a second operating system 218 such as, for example, Windows, AIX, Unix, MVS, LINUX, etc.

In certain embodiments, host computer 210 includes a storage management
5 program 214. The storage management program 214 in the host computer 210 may include the functionality of storage management type programs known in the art that manage the transfer of data to a data storage and retrieval system, such as the IBM DFSMS implemented in the IBM MVS operating system.

Storage management program 214 may include known storage management
10 program functions, such as recall and migration. The storage management program 214 may be implemented within the operating system 212 of the host computer 210 or as a separate, installed application program 216. Alternatively, storage management program 214 may include device drivers, backup software, application programs 216, and the like.

Host computer 220 comprises a computer system, such as a mainframe, personal
15 computer, workstation, and combinations thereof, including an operating system 222 such as Windows, AIX, Unix, MVS, LINUX, etc. In certain embodiments, host computer 220 further includes a second operating system 228 such as, for example, Windows, AIX, Unix, MVS, LINUX, etc.

In certain embodiments, host computer 220 includes a storage management
20 program 224. The storage management program 224 in the host computer 220 may include the functionality of storage management type programs known in the art that

manage the transfer of data to a data storage and retrieval system, such as the IBM DFSMS implemented in the IBM MVS operating system.

Storage management program 224 may include known storage management program functions, such as recall and migration. The storage management program 224
5 may be implemented within the operating system 222 of the host computer 220 or as a separate, installed application program 226. Alternatively, storage management program 214 may include device drivers, backup software, application programs 226, and the like.

Host computer 230 comprises a computer system, such as a mainframe, personal computer, workstation, and combinations thereof, including an operating system 232
10 such as Windows, AIX, Unix, MVS, LINUX, etc. In certain embodiments, host computer 230 further includes a second operating system 238 such as, for example, Windows, AIX, Unix, MVS, LINUX, etc.

In certain embodiments, host computer 230 includes a storage management program 234. The storage management program 234 in the host computer 230 may
15 include the functionality of storage management type programs known in the art that manage the transfer of data to a data storage and retrieval system, such as the IBM DFSMS implemented in the IBM MVS operating system.

Storage management program 234 may include known storage management program functions, such as recall and migration. The storage management program 234
20 may be implemented within the operating system 232 of the host computer 210 or as a separate, installed application program 236. Alternatively, storage management program 234 may include device drivers, backup software, application programs 236, and the like.

In the illustrated embodiment of FIG. 2A, host computer 210 is capable of communicating with SAN 240 via a plurality of communication links 219. In the illustrated embodiment of FIG. 2A, plurality of communication links 219 includes communication links 211, 213, 215, and 217. In other embodiments, host computer 210 is capable of communicating with SAN 240 via fewer than four communication links. In other embodiments, host computer 210 is capable of communicating with SAN 240 via more than four communication links. In certain embodiments, communication links 211, 213, 215, and 217, are each selected from the group consisting of a serial interconnection, such as RS-232 or RS-422, an Ethernet interconnection, a SCSI interconnection, a Fibre Channel interconnection, an ESCON interconnection, a FICON interconnection, a Local Area Network (LAN), a private Wide Area Network (WAN), a public wide area network, Storage Area Network (SAN), Transmission Control Protocol/Internet Protocol (TCP/IP), the Internet, or other interconnections and/or protocols as is known to those of skill in the art.

In the illustrated embodiment of FIG. 2A, host computer 220 is capable of communicating with SAN 240 via a plurality of communication links 229. In the illustrated embodiment of FIG. 2A, plurality of communication links 229 includes communication links 221, 223, 225, and 227. In other embodiments, host computer 220 is capable of communicating with SAN 240 via fewer than four communication links. In other embodiments, host computer 220 is capable of communicating with SAN 240 via more than four communication links. In certain embodiments, communication links 221, 223, 225, and 227, are each selected from the group consisting of a serial interconnection,

such as RS-232 or RS-422, an Ethernet interconnection, a SCSI interconnection, a Fibre Channel interconnection, an ESCON interconnection, a FICON interconnection, a Local Area Network (LAN), a private Wide Area Network (WAN), a public wide area network, Storage Area Network (SAN), Transmission Control Protocol/Internet Protocol (TCP/IP),
5 the Internet, or other interconnections and/or protocols as is known to those of skill in the art.

In the illustrated embodiment of FIG. 2A, host computer 230 is capable of communicating with SAN 240 via a plurality of communication links 239. In the illustrated embodiment of FIG. 2A, plurality of communication links 239 includes
10 communication links 231, 233, 235, and 237. In other embodiments, host computer 230 is capable of communicating with SAN 240 via fewer than four communication links. In other embodiments, host computer 230 is capable of communicating with SAN 240 via more than four communication links. In certain embodiments, communication links 231, 233, 235, and 237, are each selected from the group consisting of a serial interconnection,
15 such as RS-232 or RS-422, an Ethernet interconnection, a SCSI interconnection, a Fibre Channel interconnection, an ESCON interconnection, a FICON interconnection, a Local Area Network (LAN), a private Wide Area Network (WAN), a public wide area network, Storage Area Network (SAN), Transmission Control Protocol/Internet Protocol (TCP/IP), the Internet, or other interconnections and/or protocols as is known to those of skill in the
20 art.

SAN 240 comprises a storage area network, and is capable of communicating with information storage and retrieval system 250 via a plurality of communication links

270. In the illustrated embodiment of FIG. 2A, plurality of communication links 270 includes communication links 272, 274, and 276. In other embodiments, plurality of communication links 270 includes fewer than three communication links. In other embodiments, plurality of communication links 270 includes more than three
5 communication links. In certain embodiments, communication links 272, 274, and 276, are each selected from the group consisting of an Ethernet interconnection, a SCSI interconnection, a Fibre Channel interconnection, an ESCON interconnection, a FICON interconnection, a Local Area Network (LAN), a private Wide Area Network (WAN), a public wide area network, Storage Area Network (SAN), Transmission Control
10 Protocol/Internet Protocol (TCP/IP), the Internet, or other interconnections and/or protocols as is known to those of skill in the art.

In the illustrated embodiment of FIG. 2B, host computer 210 is capable of communicating with information storage and retrieval system 250 via a plurality of communication links 219. In the illustrated embodiment of FIG. 2B, plurality of
15 communication links 219 includes communication links 211, 213, 215, and 217. In other embodiments, host computer 210 is capable of communicating with information storage and retrieval system 250 via fewer than four communication links. In other embodiments, host computer 210 is capable of communicating with information storage and retrieval system 250 via more than four communication links. In certain
20 embodiments, communication links 211, 213, 215, and 217, are each selected from the group consisting of an Ethernet interconnection, a SCSI interconnection, a Fibre Channel interconnection, an ESCON interconnection, a FICON interconnection, a Local Area

Network (LAN), a private Wide Area Network (WAN), a public wide area network, Storage Area Network (SAN), Transmission Control Protocol/Internet Protocol (TCP/IP), the Internet, or other interconnections and/or protocols as is known to those of skill in the art.

5 In the illustrated embodiment of FIG. 2B, host computer 220 is capable of communicating with information storage and retrieval system 250 via a plurality of communication links 229. In the illustrated embodiment of FIG. 2B, plurality of communication links 229 includes communication links 221, 223, 225, and 227. In other embodiments, host computer 210 is capable of communicating with information storage and retrieval system 250 via fewer than four communication links. In other
10 embodiments, host computer 210 is capable of communicating with information storage and retrieval system 250 via more than four communication links. In certain embodiments, communication links 221, 223, 225, and 227, are each selected from the group consisting of an Ethernet interconnection, a SCSI interconnection, a Fibre Channel
15 interconnection, an ESCON interconnection, a FICON interconnection, a Local Area Network (LAN), a private Wide Area Network (WAN), a public wide area network, Storage Area Network (SAN), Transmission Control Protocol/Internet Protocol (TCP/IP), the Internet, or other interconnections and/or protocols as is known to those of skill in the art.

20 In the illustrated embodiment of FIG. 2B, host computer 230 is capable of communicating with information storage and retrieval system 250 via a plurality of communication links 239. In the illustrated embodiment of FIG. 2B, plurality of

communication links 239 includes communication links 231, 233, 235, and 237. In other embodiments, host computer 210 is capable of communicating with information storage and retrieval system 250 via fewer than four communication links. In other embodiments, host computer 210 is capable of communicating with information storage and retrieval system 250 via more than four communication links. In certain
5 embodiments, communication links 231, 233, 235, and 237, are each selected from the group consisting of an Ethernet interconnection, a SCSI interconnection, a Fibre Channel interconnection, an ESCON interconnection, a FICON interconnection, a Local Area Network (LAN), a private Wide Area Network (WAN), a public wide area network,
10 Storage Area Network (SAN), Transmission Control Protocol/Internet Protocol (TCP/IP), the Internet, or other interconnections and/or protocols as is known to those of skill in the art.

 In the illustrated embodiments of FIGs. 2A and 2B, information storage and retrieval system 250 is shown further including logical volumes 251, 252, 253, 254, 255,
15 256, and 257. In other embodiments, information storage and retrieval system 250 comprises more than seven logical volumes. Information storage and retrieval system 250 further includes controller 258 and non-volatile memory 259.

 In certain embodiments, the logical volumes disposed in information storage and retrieval system 250 are written to one or more DASD devices. In certain embodiments,
20 the logical volumes disposed in information storage and retrieval system are written to one or more hard disks. In certain embodiments, the logical volumes disposed in information storage and retrieval system are written to one or more hard disks, where

those hard disks are configured in one or more hard disk arrays. In certain embodiments, the logical volumes disposed in information storage and retrieval system are written to one or more magnetic tapes.

In certain embodiments, Applicants' information storage and retrieval system 250
5 comprises an automated media library comprising a plurality of tape cartridges, one or more robotic accessors, and one or more tape drives. U.S. Pat. 5,970,030, assigned to the common assignee herein, describes such an automated media library and is hereby incorporated by reference. In certain embodiments, Applicants' information storage and retrieval system 250 comprises a virtual tape system. U.S. Pat. No. 6,269,423, assigned
10 to the common assignee herein, describes such a virtual tape system, and is hereby incorporated by reference. In certain embodiments, Applicants' information storage and retrieval system 250 comprises information storage and retrieval system 100 (FIG. 1).

Referring now to FIG. 1, Applicants' information storage and retrieval system 100 includes a first cluster 101A and a second cluster 101B. Each cluster includes a
15 processor portion 130 / 140 and an input/output portion 160 / 170. Internal PCI buses in each cluster are connected via a Remote I/O bridge 155 / 165 between the processor portions 130 / 140 and I/O portions 160 / 170, respectively.

Information storage and retrieval system 100 further includes a plurality of host adapters 102 - 105, 107 - 110, 112 - 115, and 117 - 120, disposed in four host bays 101,
20 106, 111, and 116. Each host adapter may comprise one or more Fibre Channel ports, FICON ports, ESCON ports, or SCSI ports. Other embodiments may have host adapters comprising ports supporting other protocols known to those skilled in the art. Each host

adapter is connected to both clusters through one or more Common Platform Interconnect buses 121 and 150 such that each cluster can handle I/O from any host adapter.

Processor portion 130 includes processor 132 and cache 134. Processor portion 140 includes processor 142 and cache 144. I/O portion 160 includes non-volatile storage
5 (“NVS”) 162 and NVS batteries 164. I/O portion 170 includes NVS 172 and NVS batteries 174.

I/O portion 160 further comprises a plurality of device adapters, such as device adapters 165, 166, 167, and 168, and sixteen disk drives organized into two disk arrays, namely array “A” and array “B”. In certain embodiments, hard disk arrays “A” and “B”
10 utilize a RAID protocol. As those skilled in the art will appreciate, a RAID (Redundant Array of Independent Disks) rank combines multiple inexpensive disk drives into an array of disk drives to obtain performance, capacity and reliability that exceeds that of a single large drive.

In certain embodiments, arrays “A” and “B” comprise what is sometimes called a
15 JBOD array, i.e. *“Just a Bunch Of Disks”* where the array is not configured according to RAID. The illustrated embodiment of FIG. 1 shows two hard disk arrays. In other embodiments, Applicants’ information storage and retrieval system includes more than two hard disk arrays.

Hard disk array “A” includes disk drives 181, 182, 183, 184, 191, 192, and 193.
20 Hard disk array “B” includes disk drives 185, 186, 187, 188, 195, 196, 197, and 198. In the illustrated embodiment of FIG. 1, each loop includes at least two spare disks, namely disks 184 and 195. Each of the hard disk arrays includes one of those spare disks.

Referring again to FIGs. 2A and 2B, in certain embodiments, host computer 210 is owned by a first person. In certain embodiments, host computer 220 is owned by a second person. In certain embodiments, host computer 230 is owned by a third person. In certain embodiments, two or more of the first person, the second person, and/or the third person, differ. As those skilled in the art will appreciate, it is desirable to limit access by, for example, the first person to only logical volumes comprising information owned by that first person. Similarly, it is desirable to limit access by the second person and by the third person to logical volumes comprising information owned by that second person or third person, respectively.

In certain embodiments, the storage system which includes information storage and retrieval system 250, and optionally one or more storage area networks, such as storage area network 240, is owned by a fourth person. In certain embodiments, that fourth person differs from the first person, the second person, and/or the third person. In order to limit the access by the first person, and/or the second person, and/or the third person, to some but not all the logical volumes disposed in information storage and retrieval system 250, the fourth person must implement an apparatus and method to control access to the logical volumes disposed in information storage and retrieval system 250. .

Applicants' invention includes a method to control access to logical volumes disposed in an information storage and retrieval system. FIG. 3 summarizes certain initial steps in Applicants' method.

Referring now to FIG. 3, in step 310 Applicants' method provides an information storage and retrieval system, such as system 250 (FIG. 2), where that information storage and retrieval system includes a plurality of logical volumes, such as plurality of logical volumes 262, 264, 266, 268, 272, 274, 276.

5 In step 320, Applicant's method provides a plurality of host computers, such as host computer 210, 220, 230, where each of those host computers are capable of communicating with the information storage and retrieval system.

 In step 330, Applicant's method forms (N) host computer groups, where (N) is equal to or greater than 1. In certain embodiments, one or more of those host computer groups includes one host computer. In certain embodiments, one or more of those host computer groups includes two or more host computers. In certain embodiments, step 330 is performed by a storage system owner and/or operator, such as the owner and/or operator of information storage and retrieval system 250 (FIG. 2). In certain embodiments, step 330 is performed by a controller, such as controller 258, disposed in Applicants' information storage and retrieval system.

10 Applicants' information storage and retrieval system.

15 Applicants' information storage and retrieval system.

 In certain embodiments, Applicants' method includes step 340 wherein the method creates and assigns a unique and persistent identifier to each of the plurality of interconnected host computers. In certain embodiments, the unique identifier assigned to a host computer in step 340 comprises a World Wide Node Name. In certain embodiments, the unique identifier assigned to a host computer in step 340 comprises one or more World Wide Port Name.

20 embodiments, the unique identifier assigned to a host computer in step 340 comprises one or more World Wide Port Name.

In certain embodiments, Applicants' method assigns to each host computer one or more World Wide Port Names ("WWPNs"), where each I/O port disposed in that host computer could be assigned a different WWPN. Thus, a host computer comprising (M) ports could be assigned (M) different WWPNs. Using these prior art methods, host
5 computer 210 could comprise four different WWPNs, i.e. a different WWPN for each of adapters 211, 213, 215, and 217.

In certain embodiments, step 340 is performed by a storage system owner and/or operator, such as the owner and/or operator of information storage and retrieval system 250 (FIG. 2). In certain embodiments, step 340 is performed by a controller, such as
10 controller 258, disposed in Applicants' information storage and retrieval system.

In step 350, Applicants' method assigns each host computer capable of communicating with the information storage and retrieval system to one of the (N) host computer groups. In certain embodiments, step 350 is performed by a storage system owner and/or operator, such as the owner and/or operator of information storage and
15 retrieval system 250 (FIG. 2). In certain embodiments, step 350 is performed by a controller, such as controller 258, disposed in Applicants' information storage and retrieval system.

In step 360, Applicants' method forms (N) logical volume groups. In certain embodiments, step 360 is performed by a storage system owner and/or operator, such as
20 the owner and/or operator of information storage and retrieval system 250 (FIG. 2). In certain embodiments, step 330 is performed by a controller, such as controller 258, disposed in Applicants' information storage and retrieval system.

In step 370, Applicants' method assigns one or more of the plurality of logical volumes of step 310 to one or more of the (N) logical volume groups of step 360, such that each assigned logical volume is assigned to a single logical volume group. In certain embodiments, step 370 is performed by a storage system owner and/or operator, such as the owner and/or operator of information storage and retrieval system 250 (FIG. 2). In certain embodiments, step 370 is performed by a controller, such as controller 258, disposed in Applicants' information storage and retrieval system. In the event one or more logical volumes are not assigned to any of the (N) logical volumes groups, then those volumes remain "unassigned."

10 In step 380, Applicants' method maintains a database, where that database associates each of the (N) host computer groups with the corresponding logical volume group. In certain embodiments, the database of step 380 also associates each unique identifier assigned in step 340 to one of the (N) host computer groups. In certain embodiments, the database of step 380 is saved in non-volatile memory, such as memory 15 259, disposed in Applicants' information storage and retrieval system.

Applicants' method transitions from step 380 to step 410 (FIG. 4). FIG. 4 summarizes additional steps in Applicants' method to control access to the plurality of logical volumes disposed on Applicants' information storage and retrieval system 250 (FIG. 2). Referring now to FIG. 4, in step 410 Applicants' information storage and 20 retrieval system, such as system 200 (FIG. 2A) / 201 (FIG. 2B), receives a request from an interconnected host computer, such as host computer 210 (FIG. 2), to access a designated logical volume, such as logical volume 262 (FIG. 2).

In certain embodiments, the request of step 410 includes addressing information that Applicants' information storage and retrieval system uses to determine the unique identifier assigned to the requesting host in step 340 (FIG. 3). In embodiments wherein the requesting host communicates with Applicants' information storage and retrieval system via a Fibre Channel link, the relationship between the unique identifier assigned in step 340 and the Fibre Channel link address is established through a Fibre Channel login process.

In step 420, Applicants' method determines that the requesting host is assigned to the (j)th host computer group, wherein (j) is greater than or equal to 1 and less than or equal to (N). In certain embodiments, step 420 is performed by a controller, such as controller 258 (FIG. 2), disposed in Applicants' information storage and retrieval system, such as system 250 (FIG. 2).

Applicants' method transitions from step 420 to step 430 wherein the method determines if the designated logical volume of step 410 is assigned to the (j)th logical volume group. In certain embodiments, step 420 is performed by a controller, such as controller 258 (FIG. 2), disposed in Applicants' information storage and retrieval system, such as system 250 (FIG. 2).

If Applicants' method determines in step 430 that the designated logical volume of step 410 is assigned to the (j)th logical volume group, then the method transitions to step 450 wherein the method permits the requesting host computer, assigned to the (j)th host computer group, to access the designated logical volume which is assigned to the (j)th logical volume group. Alternatively, if Applicants' method determines in step 430

that the designated logical volume of step 410 is not assigned to the (j)th logical volume group, then the method transitions to step 440 wherein the method does not permit the requesting host computer, assigned to the (j)th host computer group, to access the designated logical volume which is not assigned to the (j)th logical volume group.

5 FIG. 5 summarizes additional steps in Applicants' method, wherein access rights to one or more logical volumes is changed. Referring now to FIG. 5, in certain embodiments step 510 includes receiving a request made by the owner / operator of a host computer group by the owner of the storage system.

 The request of step 510 may include assigning and/or unassigning one or more
10 host computers from a host computer group, and/or assigning and/or unassigning one or more logical volumes from a logical volume group. The steps of Applicants' method summarized in FIG. 5 are used to change the access rights to logical volumes disposed in an information storage and retrieval system, where those logical volumes are not in a copy services relationship, and where parallel access volumes are not used.

15 Controlling access rights to logical volumes where one or more of those logical volumes may be in a copy services relationship is described in an application entitled "Apparatus and Method to Control Access to Logical Volumes Using Copy Services", filed on even date herewith and assigned to common assignee hereof. Controlling access rights to logical volumes where one or more of those logical volumes comprises a base
20 logical volume for one or more parallel access volumes is described in an application entitled "Apparatus and Method to Control Access to Logical Volumes Using Parallel Access Volumes", filed on even date herewith and assigned to common assignee hereof.

In response to a request to change access rights, Applicants' method transitions to step 520 wherein the method determines if the request includes unassigning one or more host computers from a host computer group, such as for example the (k)th host computer group, where that request is made by the owner / operator of the (k) host computer group.

5 If Applicants' method determines in step 520 that the owner / operator of the (k)th host computer group does not request that one or more host computers currently assigned to the (k)th host compute group be unassigned, then the method transitions from step 520 to step 530. If Applicants' method determines in step 520 that the owner / operator of the (k)th host computer group requests that one or more host computers currently assigned to
10 the (k)th host computer group be unassigned, then the method transitions from step 520 to step 525 wherein the method unassigns those one or more host computers. In certain embodiments, step 525 is performed by the owner / operator of the storage system.

Applicants' method transitions from step 525 to step 530, wherein the method determines if the owner / operator of the (k)th host computer group requests that one or
15 more additional host computers be assigned to the host computer group. If Applicants' method determines in step 530 that the owner / operator of the (k)th host computer group does not request that one or more additional host computers be assigned to the host computer group, then Applicants' method transitions from step 530 to step 540.

Alternatively, if Applicants' method determines in step 530 that the owner / operator of
20 the (k)th host computer group requests that one or more additional host computers be assigned to the host computer group, then Applicants' method transitions to step 535 wherein the method assigns those one or more additional host computers to the (k)th host

computer group. In certain embodiments, step 535 is performed by the owner / operator of the storage system.

Applicants' method transitions from step 535 to step 540, wherein the method determines if the owner / operator of the (k)th host computer group requests that one or more logical volumes assigned to the (k)th logical volume group be unassigned. If Applicants' method determines in step 540 that the owner / operator of the (k)th host computer group does not request one or more logical volumes assigned to the (k)th logical volume group be unassigned, then Applicants' method transitions from step 540 to step 550. Alternatively, if Applicants' method determines in step 540 that the owner / operator of the (k)th host computer group requests that one or more logical volumes assigned to the (k)th logical volume group be unassigned, then Applicants' method transitions to step 545 wherein the method unassigns those one or more logical volumes from the (k)th logical volume group. In certain embodiments, step 535 is performed by the owner / operator of the storage system.

Applicants' method transitions from step 545 to step 550, wherein the method determines if the owner / operator of the (k)th host computer group requests that one or more logical volumes be assigned to the (k)th logical volume group. If Applicants' method determines in step 550 that the owner / operator of the (k)th host computer group does not request that one or more logical volumes be assigned to the (k)th logical volume group, then Applicants' method transitions from step 550 to step 560 and ends.

Alternatively, if Applicants' method determines in step 550 that the owner / operator of the (k)th host computer group requests that one or more logical volumes be

assigned to the (k)th logical volume group, then Applicants' method transitions to step 552 wherein the method assigns one or more logical volumes to the (k)th logical volume group. In certain embodiments, step 552 is performed by the owner / operator of the storage subsystem. Applicants' method transitions from step 552 to step 554 wherein the
5 storage system owner / operator assigns identifiers to the logical volumes assigned in step 552, and provides those identifiers to the owner / operator of the (k)th host computer system. In certain embodiments, Applicants' method transitions from step 554 to step 560 and ends.

In certain embodiments, a host computer assigned to the (k)th host computer
10 group can utilize an auto configuration process or discovery techniques to locate the logical volumes newly-added to the (k)th logical volume group. In other embodiments, Applicants' method includes step 556 wherein the owner / operator of the (k)th host computer group revises the (k)th host computer Input / Output Control Dataset ("IOCDS") to define access rights to the newly-assigned logical volumes of step 552.
15 Applicants' method transitions from step 556 to step 560 and ends.

The embodiments of Applicants' method recited in FIGs. 3, 4, and/or 5, may be implemented separately. Moreover, in certain embodiments, individual steps recited in FIGs. 3, 4, and/or 5, may be combined, eliminated, or reordered.

In certain embodiments, Applicants' invention includes instructions residing in
20 non-volatile memory 259 (FIG. 2), where those instructions are executed by controller 258 (FIG. 2) to performs steps 330, 340, 350, 360, 370, and 380 in FIG. 3, and/or steps 410 through 450 recited in FIG. 4, and/or steps 520 through 560 recited in FIG. 5. In

other embodiments, Applicants' invention includes instructions residing in any other computer program product, where those instructions are executed by a computer external to, or internal to, system 200 (FIG. 2A) / 201 (FIG. 2B), to perform steps 330, 340, 350, 360, 370, and 380 in FIG. 3, and/or steps 410 through 450 recited in FIG. 4. In either
5 case, the instructions may be encoded in an information storage medium comprising, for example, a magnetic information storage medium, an optical information storage medium, an electronic information storage medium, and the like. By "electronic storage media," Applicants mean, for example, a device such as a PROM, EPROM, EEPROM, Flash PROM, compactflash, smartmedia, and the like.

10 While the preferred embodiments of the present invention have been illustrated in detail, it should be apparent that modifications and adaptations to those embodiments may occur to one skilled in the art without departing from the scope of the present invention as set forth in the following claims.